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Effect of replacing fishmeal with *Spirulina* spp. on carcass chemical composition of common carp *Cyprinus carpio* L.

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Abstract

This study was conducted to evaluate the effect of replacing fishmeal with *Spirulina* spp. in four different levels 0%, 5%, 10%, 15% and 20%, as T1, T2, T3, T4and T5 respectively on Carcass means weight (CMW) with head and without peripheral organs and CMW without head and peripheral organs, where the third and fifth treatment give the higher value in CMW with head and without peripheral organs, and the fifth treatment obtain significant differences in CMW without head and peripheral organs as compared to other treatment. When regarding the chemical composition in which the higher significant difference found in the T3 and T5 in crude protein, the T5 significantly differ in crude fat as compared with other treatments.

Keywords: Fishmeal; *Spirulina*; Carcass Composition
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تأثير استبدال عليقة السمك بالسبيرولينا في التركيب الكيميائي لجسم سمكة الكارب

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الخلاصة

أُجريت هذه الدراسة لتقييم استبدال عليقة السمك بالسبيرولينا في التركيب الكيميائي لجسم سمكة الكارب مع الرأس أو بدونه وبدون الاحشاء الداخلية على مستويات صفر و ٥و ١٠ و ١٥ ٢٠%. أعطى كل من المستوى الثالث والخامس أعلى قيمة للوزن بوجود الرأس وبدون الأحشاء، في حين كانت القيمة أعلى بالمستوى بدون الرأس والأحشاء الداخلية. كانت قيمة البروتين أعلى بالعلاج الثالث والخامس وقيمة الدهن أعلى بالعلاج الخامس مقارنة بالعلاجات الأخرى.

Introduction

The population of Iraq is increasing and the need for food and protein sources, aquaculture and optimum utilization of available water resources are more obvious in recent years. Considering the importance of this role in providing healthy fish meat and its use more reveal compared to the developed countries. One of the branches of aquaculture is fish culture, which are divided into two categories: freshwater and seawater (1). Many fishes were living in fresh water, one of the most popular of them is carp *Cyprinus carpio* L.

Mainly, one of the fish species for acceptable taste, aroma, and white flesh farmed in worldwide countries such as Iraq is common carp. Furthermore, presence food with high quality and low cost is one of the important factors in aquaculture (2). Common protein sources, which are used in Iraq aquaculture, include: fishmeal (FM), since many years ago, FM is used to as a protein sources in the aquaculture, poultry and pigs production (3). There are about more than 300 finfish species, 30 species of shrimp that are commercially cultivated worldwide for which fishmeal, in varying inclusions forms the basis of intensively, and some semi-intensively culturedaquatic species(4).

Recently, *Spirulina* (blue-green alga) is becoming a health food worldwide; it is a multicultural, filamentous Cyan bacterium belonging to algae of the class *Cyanophyta*.

In addition, *Spirulina* is one of the naturalresources, which contain high protein, amino acids, vitamin, minerals, essential fatty acid, B-complex and β-carotene (5). Previous researchers demonstrated that *Spirulina* capable to breaking down indigestible feed components and improve the intestinal flora in fish (6).

Spirulina is a planktonic filamentous cyanobacterium, It has multicellular left-handed helical trichomes, composed of shorterthan broad cells (mean cell diameter 8mm), and shows gliding motility by rotationalong its axis, the most cultivated phototrophic prokaryote as food supplement, isalso used as a source of feed and fine chemicals, and exploited as a therapeutic agent (7).

There is increasing recognition for the importance of aquaticmacrophytes as feed in aquaculture, *Spirulina platensis*, afilamentouscyanobacterium, possesses diverse biological and nutritional significance. It has the potentiality toproduce large numbers of antimicrobialsubstances; therefore, it is considered a suitable candidate forexploitation as bio-control agent against pathogenic micro-organisms (8).

Optimization of dried form of whole *S. platensis* concentration in fish diets is still questionable, regarding itsoptimum concentration needed to reach its desired effects on growth performance, feed utilization, immuneresponses, and resistance of tilapias to infections (9).

The *Spirulina* alga is rich in protein and vitamins, andcan be used to improve the immunity capacity of theanimals that consume it. Consumption of *Spirulina* algaalso increases the ability to absorb nutrients. When*Spirulina* alga is used as feed for young prawns andfingerlings, the fish exhibit good coloring, as well asmaintain a low death rate and a high growth rate (8).

The main propose of this study was to investigate the effect of replacing different levels of fishmeal with *Spirulina* on carcass composition.

Material and methods

The experiment was conducted for 105 days and for these purpose 200 fingerlings common carp *C. carpio* L. were brought from a local aquarium fish supplier located in Kuit, in middle of Iraq. The size of fish was varying and the mean initial weight was 35.7g. The fish were sorted depending on size then weighed and put in experimental plastic aquariums. The fish were acclimated to laboratory conditions and fed with control pellets (32% protein) prior to the feeding trials for 21 days.

Experimental system and design

Twenty plastic aquariums (100 L) were used in this trial. Each tank was provided with a proper continuous aeration. Each aquarium was stocked with seven fish and fed two times a day. The aquaria (replicates) were randomly allocated to minimize differences among treatments. The continuous water flow discharged non-consumed feed and feces particles from the aquaria. Also, a daily cleaning by siphon method was applied to remove remained particles from the system.

In T1 fish were fed a diet replacing fishmeal with 0% *Spirulina* formulated diet, while in T2, fish were fed a diet replacing fishmeal with 5% *Spirulina*, T3 represents the third treatment, in which fish were fed on a diet replacing fishmeal with 10% *Spirulina*, while, in T4 fish were fed a diet replacing fishmeal with 15% *Spirulina*, and final treatment T5 replacing fishmeal with 20% *Spirulina*.

Analysis of variance was conducted using the general linear models (GLM) procedure of XLSTAT. Pro. 7.5 one way (ANOVA). Fisher's L.S.D test's was used to compare between means of the control and experiment treatments.

Diet formulation

Experimental diets were prepared with fishmeal, wheat bran, soybean, broken rice, multivitamin and *Spirulina*, and the chemical composition of the different diet shown in Table (1). The ingredients were mixed with water to obtain dough. Then, the dough was passed through an electrical mincer for pelleting by using Kenwood Multi-processors. The pellets were dried at room temperature 25 °C for a few days and crushed to yield fine particles. The fish were fed 2 times a day, once was at 9:00 am and another time at 2:00 pm. Feeding rate started with 10% of biomass then the accurate feeding rate was determined to be 3% by third week depending on satiation level. Fish were individually weighed weekly. The feeding amount was then recalculated according to weekly weights. The feeding trial continued for 12 weeks.

Table 1: The structure and chemical composition of experimental diet

	Basis on 100 kg				
Spirulina	0%	5%	10%	15%	20%
Fishmeal	24.2	21.7	19.2	16.8	14.2
Wheatbran	35	35	35	35	35
Soybean	20	20	20	20	20
Broken Rice	20.3	17.8	15.3	12.7	10.3
Vitamin	0.5	0.5	0.5	0.5	0.5
Chemical composition					
Crude Protein %	32	32	32	32	32
Ether extract %	6.7	6.4	6.0	5.7	5.4
Fiber %	7.6	7.6	7.5	7.5	7.5

Used *Spirulina*

500g of premium sinking *Spirulina* wafers obtained from (www.ebay.com), these top quality-sinking wafers are rich in *Spirulina* suitable for all herbivorous fish such as

pleco's and catfish as well as shrimps and snails. Their chemical composition as labeled in the below table (2).

Table 2: Chemical composition of used *Spirulina* as labeled

Composition	Ratio %
Crude Protein	34%
Crude Fat and Oils	6%
Fibre	5%
Ash	10%
Vitamin A (Per kg)	24000lU
Vitamin D	2600lU
Vitamin E	280lU
Vitamin C	550mg/kg

Results and discussion

In the present study, there was a significant difference in carcass mean weight between the groups after 90 days ($P<0.05$) as shown in (table 3). Replacing different levels of *Spirulina* increased carcass mean weight (with head and without peripheral organs CMW; without head and peripheral organs) compare to control group. Also, there were significant differences in carcass parameters such as crude protein (CP) and crude fiber (CF) levels in all groups compare to control group ($P<0.05$) except ash there were no significant differences among the treatment.

The data in Table (3) showed fish carcass composition data of protein were 24.145%, 24.005%, 20.935%, 20.910% and 17.865 % for the T5, T3,T2, T1and T4 respectively, T5 had significant ($P\leq0.05$) differences as compared with the control ones and other treatments; no significant ($P\leq0.05$) different between T5 and T3.

Research conducted by (10) found that *Spirulina* alga was a good source of protein for animal feed, as well as containing high amounts of B-complex vitamins, minerals, good quality proteins, gamma-linolenic acid (GLA) and the super antioxidants, beta-carotene, vitamin E and trace elements, besides this, the cellular structure of *Spirulina* alga is easily digestible and does not contain cellulose. Different levels of *Spirulina* alga can be mixed with feeds according to the eating behaviors of the fish and differing abilities to digest the protein from plant sources. *Spirulina* contains a wide spectrum of nutrients that include *Spirulina* is fast emerging as a whole answer to the varied demands due to its impressive nutrient composition which can be used for therapeutic uses (11).

Table 3: Effects of different levels of replacing fishmeal with *Spirulina*on carcass mean weight at the end of experiment and chemical analysis of the carcass

Treatment	0% *Spirulina* by 24.2 fishmeal	5% *Spirulina* by 21.7 fishmeal	10% *Spirulina* by 19.2 fishmeal	15% *Spirulina* by 16.8 fishmeal	20% *Spirulina* by 14.2 fishmeal
CMW	32.863 c	43.145 b	52.223 a	43.163 b	54.343 a
CMW	22.048 c	29.960 b	35.710 ab	32.103 ab	37.608 a
CP	20.910 b	20.935 b	24.005 a	17.865 c	25.145 a
CF	19.920 e	21.955 d	24.775 c	30.990 b	39.045 a
Ash	1.057 a	1.193 a	1.110 a	0.967 a	1.177 a

* There were significant differences between groups with different codesin a row (Superscript letters a, b, c, d and e; $P<0.05$).

Nandeesha *et al*. (12) recorded no difference in the moisture and protein content in carcasses of common carp fed on diets incorporated with up to 55% *Spirulina* powder. However, the fat content decreased concomitant with an increased *Spirulina* supplementation level. In contrast, the feeding of algae was reported to elevate the body lipid in red sea bream. For *O. niloticus*, similar values of moisture (78.1% and 79.0%), crude protein (19.8% and 18.2%), lipid (1.8% and 1.1%) and ash (1.0% and 1.36% respectively). For *Oreochromis* sp., different results obtained from those present in this study for moisture (79.50%), crude protein (12.67%), lipid (2.05%) and ash (3.89%) (13).

The supplementation of live *Spirulina* significantly affected the protein and lipid contents in whole-fish body. The better feed intake in *Spirulina*-enriched diets may have been due to the increased fish appetite, resulting in a higher feed intake and improved growth. On the other hand, changes in the protein and lipid contents in the fish body could be linked to changes in their synthesis, deposition rate in muscle and/or different growth rates (14-18), they demonstrated there were no significant differences in protein and crude fat in Mekong Giant Catfish flesh for all diets.

The obtained data of Allam (19) showed that there are no significant ($P>0.05$) differences in moisture and dry matter between fish treatments fed Pronifer, algae and yeast and the control treatment. These results agree with the findings of Oliva-Teles and Goncalves (20). In addition, Olvera-Novoa *et al.* (21) and Kurdiekeri (22) showed that the dietary algae had no significant effect on moisture content of the fish.

From the results of Allam (19) show, that the fish treatments fed 5% algae had insignificant (P≤0.05) increase in total proteins. These findings confirm those reported that the muscle protein of red sea bream was increased as *Ascophyllum* meal supplementation increased, the role of algae on fat content are in full agreement with the finding reported that 5% dietary *Ascophyllum* meal had insignificant increase in muscle fat of red sea bream. In addition, dietary macroalge led to significant (P<0.05) increase in the crude protein of grey mullet (*Chelonlabrows*), in the same trend.

Appler and Jauncey (23) showed a decrease in lipid contents with increasing levels of algae in the diet of *S. niloticus*. In addition, Olvera-Novoa *et al*. (21) mentioned that body lipids of *O. mossambicus* showed no consistent relation to the microalgae in the diet.

For the role of algae in reduction of ash content of the fish, this explained by some researchers such as Olvera-Novoa *et al*. (21) who mentioned that the highest (P<0.05) ash value was obtained with the control diet as compared with the lowest values with the fish treatments fed microalgae, they concluded that body ash tended to decrease with increasing levels of vegetable protein in the diet.

As aforementioned, overall a lot of factors e.g. levels of *Spirulina*, production system, physiological status and endogenous factors such as nutritional status and composition involved in inconsistent of our results with the other previous reports in fish.

In this study we didn't work on degradability and digestibility parameters but according to the previous (24) and present results, we believe that because of nutritional benefits of *Spirulina* it could improve performance of fishes and increased retention in the body, due to increase carcass CP. Additionally, caused to increase carcass mean weight (with head and without peripheral organs; without head and peripheral organs) and decrease carcass CF. we suggested *Spirulina* can be used as a high quality protein source in carp industry. The increase in the world's population is accepted as the most important factor accelerating the development of the aquaculture industry. Thus, it seems possible to use of *Spirulina* as a protein source in aquaculture industry.

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